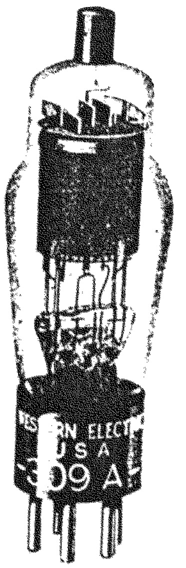
Western Electric

309A Vacuum Tube



Classification—Voltage amplifier, variable-mu, suppressor-grid pentode with indirectly heated cathode

The 309A tube is especially designed to minimize audio-frequency disturbances arising in the tube. The suppressor grid is permanently connected to the cathode within the bulb.

Applications

Audio-frequency voltage amplifier, particularly in circuits in which the amplification is adjusted by varying the control-grid bias, and exceptionally low tube noise is required.

Radio-frequency voltage amplifier.

Dimensions—Dimensions, outline diagrams of the tube and base, and the arrangement of the electrode connections to the base terminals are shown in Figures 1 and 2.

Base—Small, five-pin base with pins silver-plated. Small metal cap control-grid terminal at the top of the bulb.

Socket—Standard, five-contact type, preferably provided with silver-plated contacts such as the Western Electric 141A socket.

Mounting Positions—The 309A tube may be mounted in any position.

Average Direct Interelectrode Capacitances

Control grid to plate	0.007 $\mu\mu$f.
Control grid to heater, cathode, screen grid and suppressor grid	5.8 $\mu\mu$f.
Plate to heater, cathode, screen grid and suppressor grid	14 $\mu\mu$f.

Heater Rating

Heater voltage	10.0 volts, a.c. or d.c.
Nominal heater current	0.32 ampere

The heater element of this tube is designed to operate on a voltage basis and should be operated at as near the rated voltage as is practicable. In audio-frequency applications where exceptionally low tube noise is required, it may be necessary to use direct-current heater supply.

Cathode Connection—Preferably direct to the heater. If voltage must be applied between the cathode and heater, it should be kept as low as possible and should never exceed 150 volts.

Characteristics—Plate current and screen-grid current characteristics for a typical 309A tube are shown in Figures 3 and 4, respectively, as functions of plate voltage for several values of control-grid voltage and a screen-grid voltage of 75 volts. Corresponding amplification factor, plate resistance, and transconductance characteristics are shown in Figures 5, 6, and 7, respectively. Plate current and transconductance characteristics as functions of control-grid voltage are shown in Figures 8 and 9 respectively, for a screen-grid voltage of 75 volts and a plate voltage of 180 volts. For other plate voltages between 135 and 250 volts, the transconductance of a typical tube, for values above 5 micromhos, does not differ by more than ± 2 per cent from its value at 180 volts. Amplification factor and plate resistance characteristics as functions of control-grid voltage are shown in Figures 10 and 11, respectively, for a screen-grid voltage of 75 volts and several values of plate voltage.

Typical Operating Conditions

Plate Voltage Volts	Screen-Grid Voltage Volts	Control-Grid Bias Volts	Plate Current Milliamperes	Screen-Grid Current Milliamperes	Amplification Factor	Plate Resistance Megohms	Transconductance Micromhos
135	75	−1.5	4.75	1.1	760	0.7	1090
180	75	−1.5	4.80	1.1	1100	1.0	1100
*250	75	−1.5	4.85	1.1	1450	1.3	1110
**135-250	75	−30	—	—	—	—	5

*Maximum operating conditions
**Nominal cut-off

Microphonic Noise—With a plate voltage of 180 volts, a screen-grid voltage of 75 volts, a control-grid bias of −1.5 volts, and a load resistance of 100,000 ohms, the mean microphonic noise output level of the 309A tube, measured in a laboratory reference test set, is 17 db below 1 volt. The range of levels of individual tubes extends from 6 to 30 db below 1 volt. Since microphonic noise level depends on the type and intensity of the mechanical disturbance which produces it, the values given here are useful chiefly for comparison with the levels of other tubes which have been tested in the same way.

Fluctuation Noise—An irreducible minimum of noise in a vacuum tube is produced by minute, uncontrollable fluctuations in the rate of flow of electrons to the anode. With a plate voltage of 180 volts, a screen-grid voltage of 75 volts, a control-grid bias of −1.5 volts, and a load resistance of 100,000 ohms, the mean equivalent fluctuation noise input of the 309A tube for the audio-frequency range from 40 to 10,600 cycles is 117 db below 1 volt. The range of levels of individual tubes extends from 112 to 119 db below 1 volt. By reducing the control-grid bias to −1.0 volt and the screen-grid voltage to 18 volts, the mean fluctuation noise level may be reduced by about 2.5 db. The equivalent noise input voltage is equal to the measured output voltage divided by the voltage amplification of the tube in the measuring circuit.

Special Features—By virtue of its variable-mu characteristic and low noise level, the 309A tube is particularly adapted to amplifier applications, both radio-frequency and audio-frequency, where the amplification is adjusted by varying the control-grid bias. As the grid bias is made more negative, the plate current and transconductance approach zero gradually, as shown in Figures 8 and 9, rather than sharply, so that modulation and distortion are relatively small at all values of grid bias.

The 309A tube has been specially designed to minimize both the spontaneous microphonic noise impulses occurring at random intervals, and the sharp, aperiodic noise impulses which sometimes occur in tubes of this general type while the control-grid bias is varied continuously. When the tube is well shielded from external microphonic noise stimuli, it is exceptionally quiet in operation and can be used for the audio-frequency amplification and volume control of exceptionally low level signals.

Circuit Requirements—In order to make use of the high gain per stage of which the 309A tube is capable when used as a voltage amplifier, suitable precautions must be taken, especially where high frequencies are involved, to avoid undesired feed-back in the circuit. It may prove necessary to use a close-fitting shield around each tube, to shield each stage of the amplifier circuit, to connect a low impedance condenser between each screen grid and its corresponding cathode, to filter each battery lead to each tube, and to avoid impedances common to the plate, screen-grid, control-grid, or cathode circuits of two or more tubes.

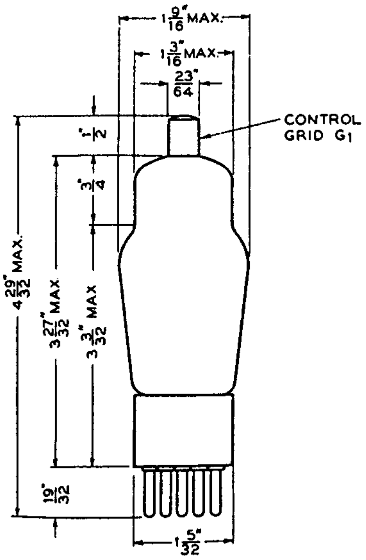


FIG. 1

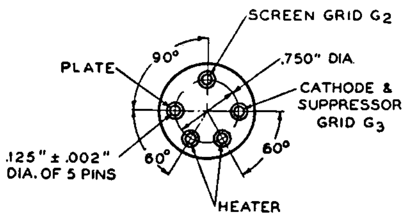


FIG. 2

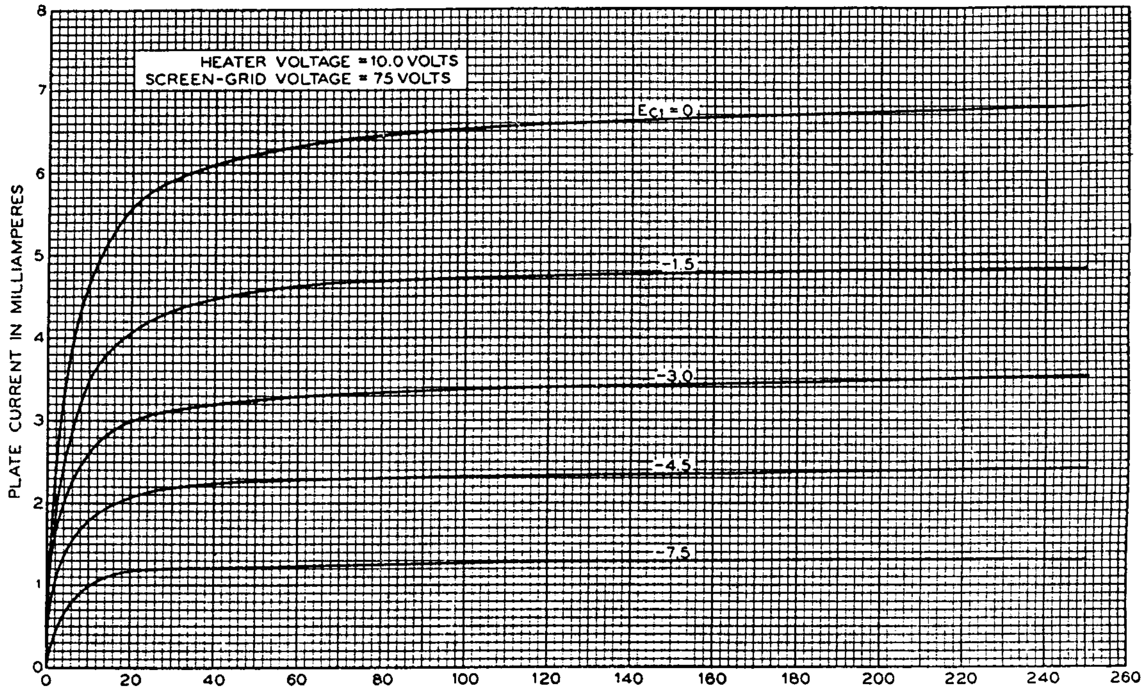

HEATER VOLTAGE = 10.0 VOLTS
SCREEN-GRID VOLTAGE = 75 VOLTS
PLATE CURRENT IN MILLIAMPERES
E_{C1} = 0
-1.5
-3.0
-4.5
-7.5
0
1
2
3
4
5
6
7
8
0
20
40
60
80
100
120
140
160
180
200
220
240
260

FIG. 3

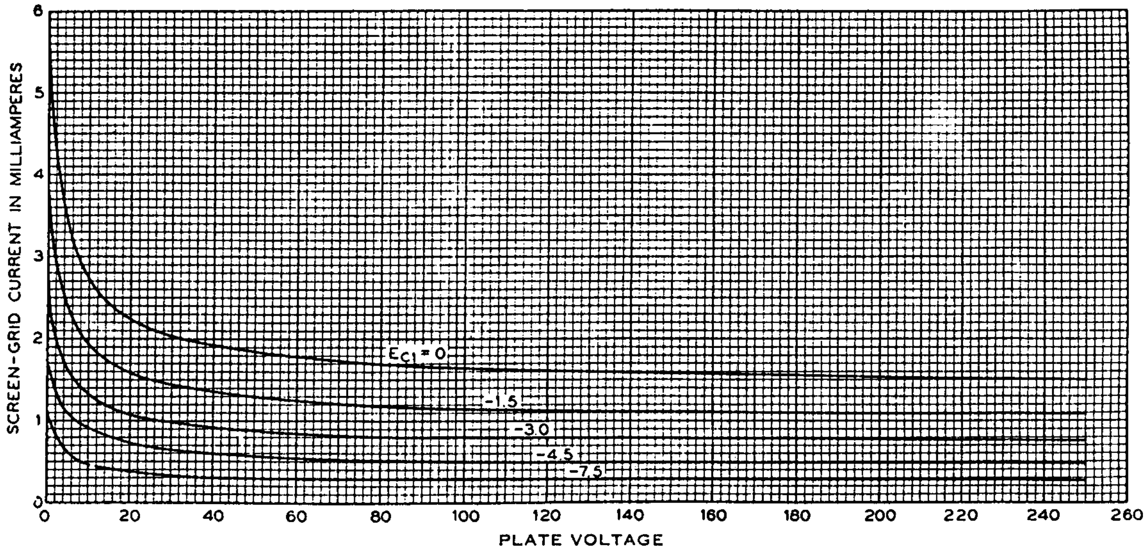

SCREEN-GRID CURRENT IN MILLIAMPERES
E_{C1} = 0
-1.5
-3.0
-4.5
-7.5
0
1
2
3
4
5
6
0
20
40
60
80
100
120
140
160
180
200
220
240
260
PLATE VOLTAGE

FIG. 4

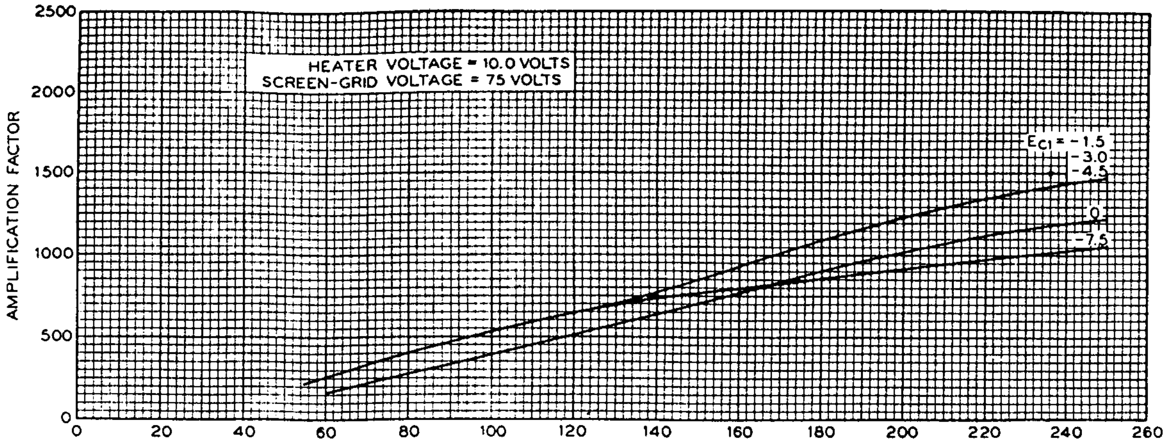


FIG. 5

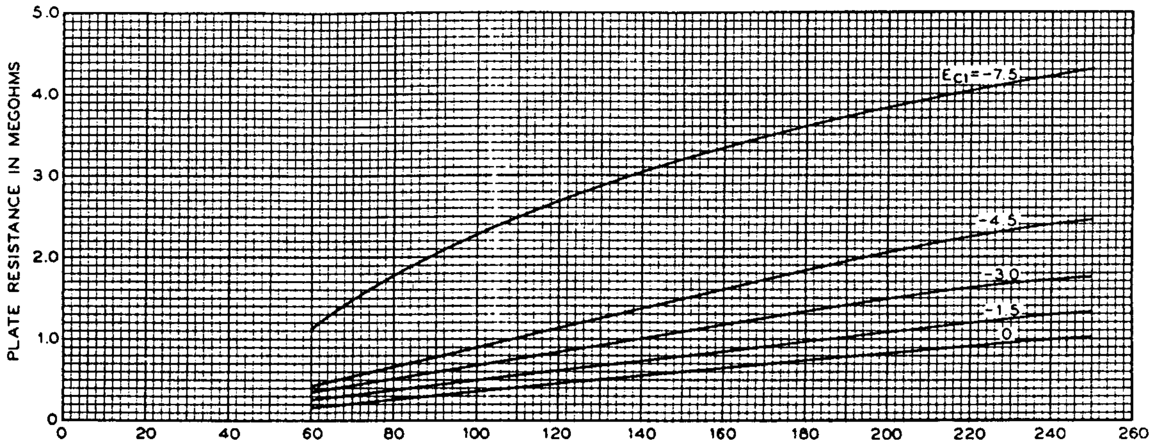


FIG. 6

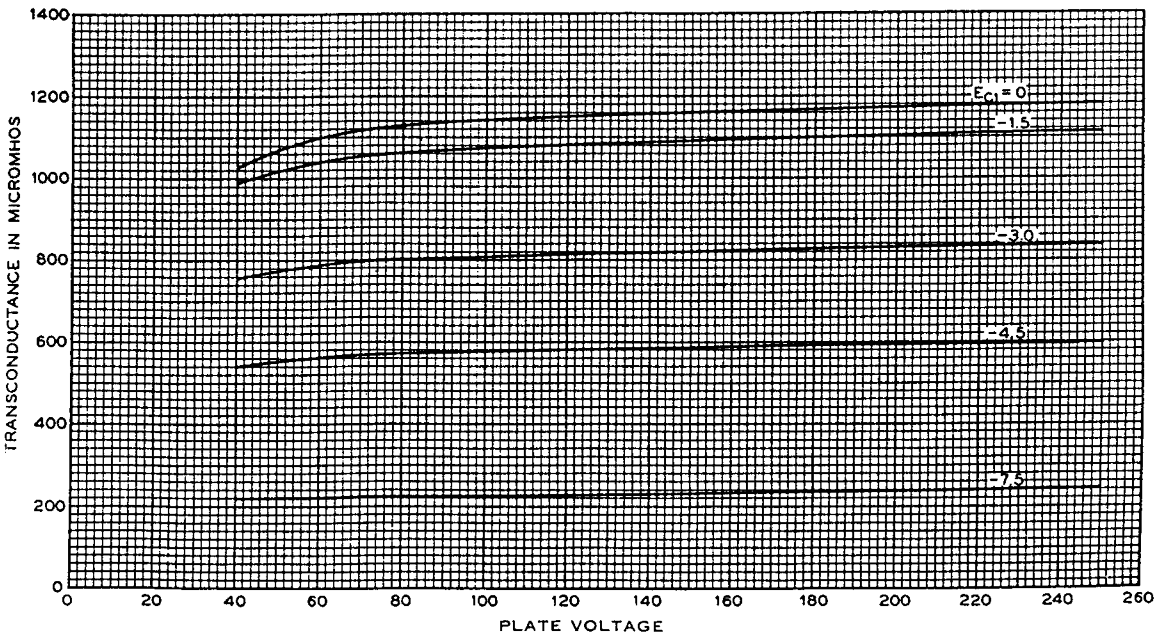
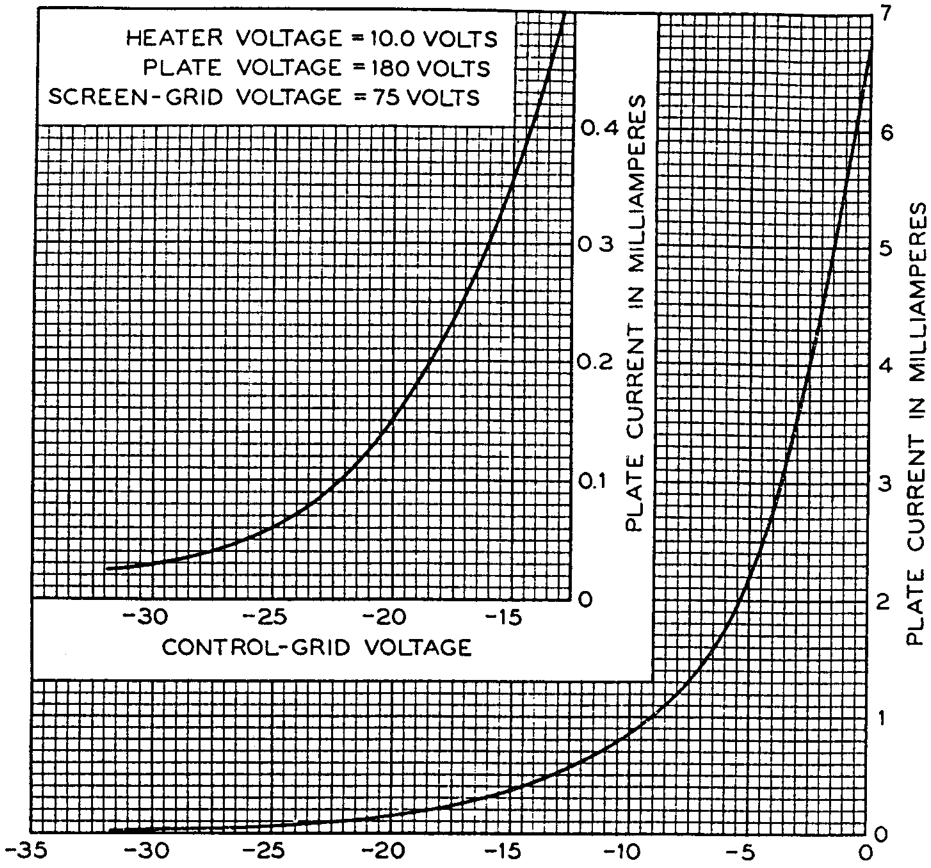
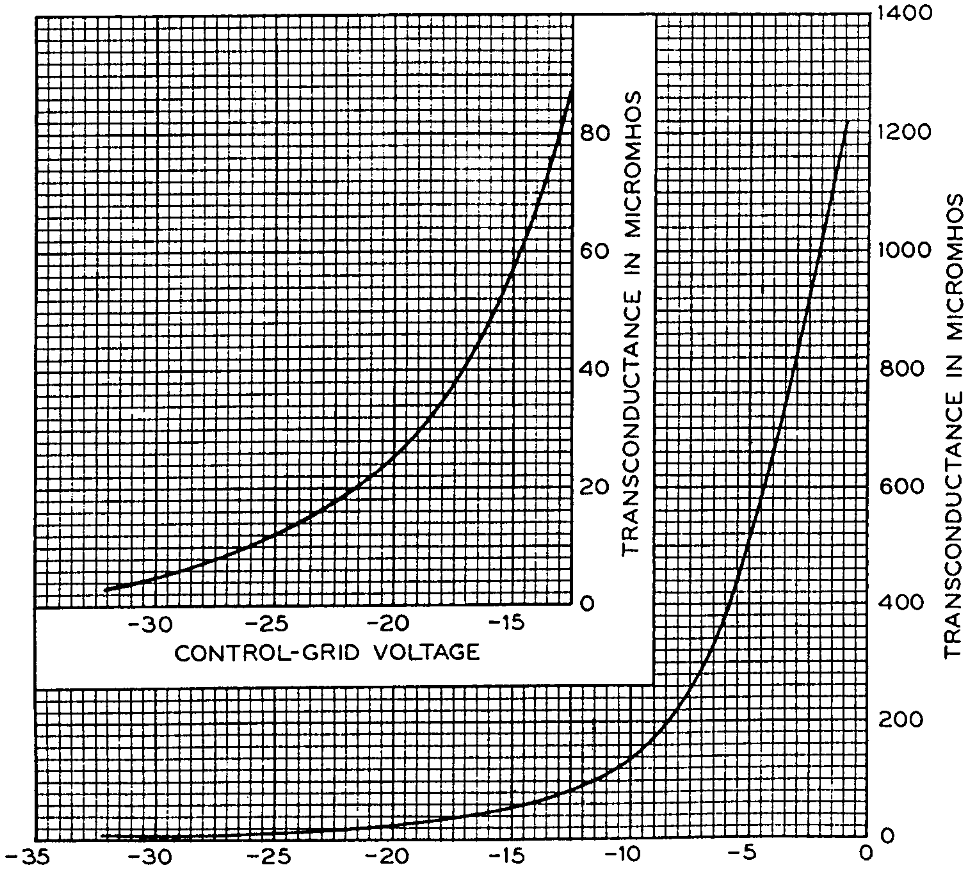


FIG. 7



HEATER VOLTAGE = 10.0 VOLTS
PLATE VOLTAGE = 180 VOLTS
SCREEN-GRID VOLTAGE = 75 VOLTS
PLATE CURRENT IN MILLIAMPERES
0.4
0 3
0.2
0.1
0
-30
-25
-20
-15
CONTROL-GRID VOLTAGE
PLATE CURRENT IN MILLIAMPERES
7
6
5
4
3
2
1
0
-35
-30
-25
-20
-15
-10
-5
0
CONTROL-GRID VOLTAGE

FIG. 8



TRANSCONDUCTANCE IN MICROMHOS
80
60
40
20
0
-30
-25
-20
-15
CONTROL-GRID VOLTAGE
TRANSCONDUCTANCE IN MICROMHOS
1400
1200
1000
800
600
400
200
0
-35
-30
-25
-20
-15
-10
-5
0
CONTROL-GRID VOLTAGE

FIG. 9

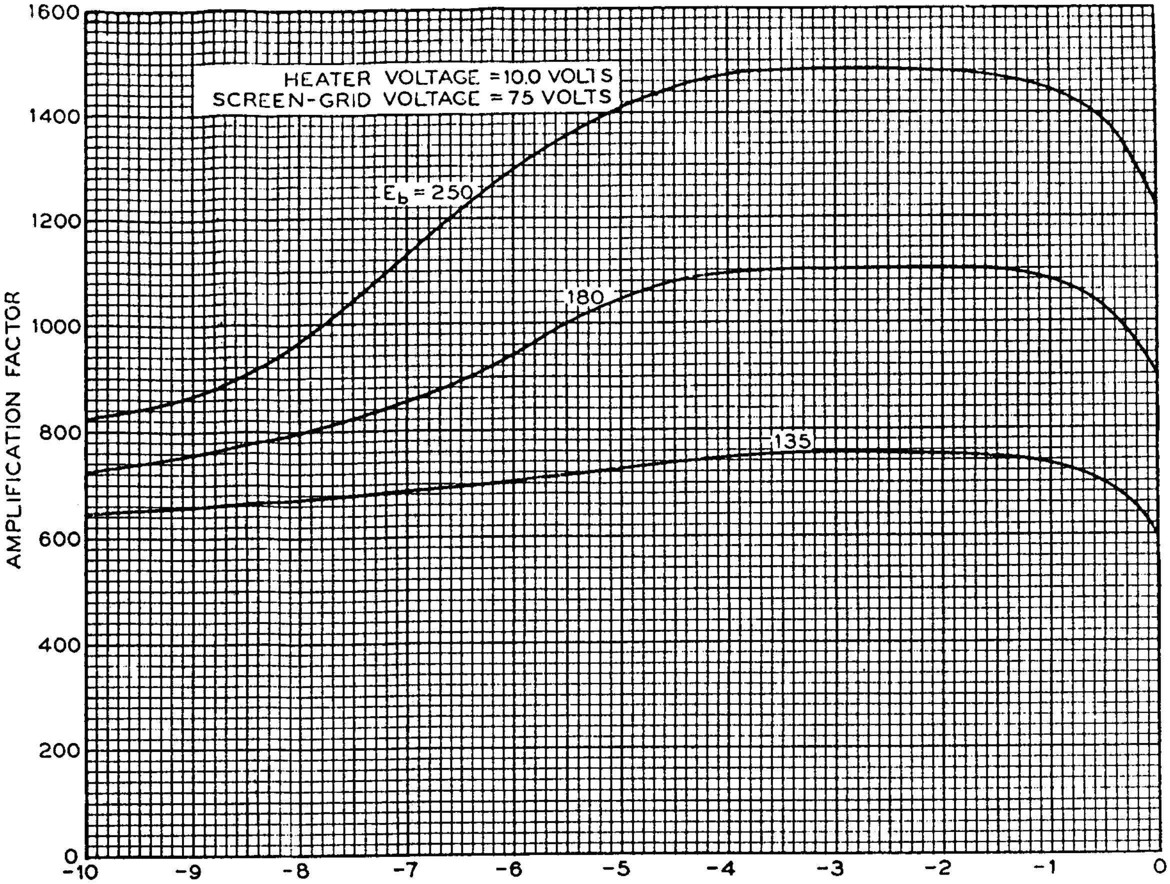

HEATER VOLTAGE =10.0 VOLTS
SCREEN-GRID VOLTAGE =75 VOLTS
AMPLIFICATION FACTOR
E_b = 250
180
135
1600
1400
1200
1000
800
600
400
200
0
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0

FIG. 10

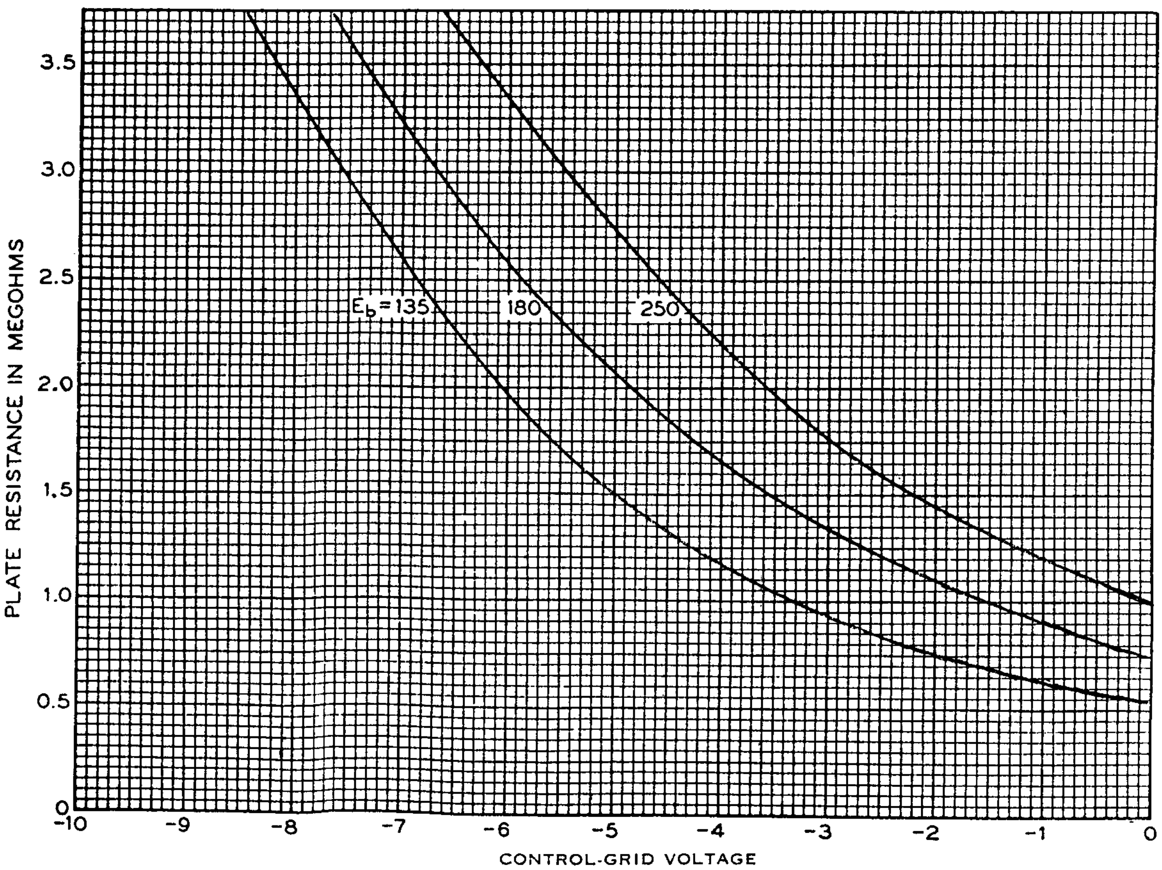

PLATE RESISTANCE IN MEGOHMS
E_b=135
180
250
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
CONTROL-GRID VOLTAGE

FIG. 11